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A NEW APPROACH FOR CANCELLATION OF INTERFERENCE FOR MORE THAN TWO USERS

SHEETALMULAY & D. E. UPASANI

Department of Electronics & Telecommunication, SITS, Narhe, University of Pune, Pune, Maharashtra, India

ABSTRACT

There are various interference cancellation techniques that are invented and presented previously. But if we consider the case of more than two users those techniques are not that much efficient. So in this paper we developed a scheme to achieve interference cancellation having a low complexity with any number of users. The main purpose of this paper is to design the precoders using channel information. Due to this it is possible for different users to transmit their signals over orthogonal directions. Then receiver can separate the transmitted signals and decode them independently by using the orthogonality of the transmitted signals. The main purpose of the project is to achieve the minimum bit error rate.

KEYWORDS: Precoder, Orthogonal Design, Interference Cancellation, BER

INTRODUCTION

Nowadays, more attention is given to multi-user detection schemes. So for this multiple antennas are used to improve the reliability as well as to increase the rate of wireless system at transmitter and receiver side. In this paper, we consider a multiple-antenna multi-access scheme. Here cancellation of interference is achieved by using the channel information. In case of two users orthogonal space time block codes have been proposed in [2]. But, it is impossible that more than two signals are not simultaneously orthogonal to each other. So, for this case we require quasi-orthogonal space time block codes. The common goal of multi-user systems are small number of required receive antennas. Also maximum-likelihood detection technique is used to achieve the full diversity for every user. But it is usually not practical, because its complexity increases exponentially as a function of the number of antennas, the bandwidth efficiency and the number of users.

So, to solve this problem in [18], here in this paper we used the channel information at the transmitters to increase the diversity of the system. But while doing all this the low complexity of the decoding is also maintained. This means that we do not use receive antennas to cancel the interference. Instead of using receive antennas we use the channel information at the transmitter to design precoders. This will align the different groups of signals along orthogonal directions. But this scheme works for two users only. So, in this paper, weextend the work in [18] and developed a scheme that works for any number of users.

BLOCK DIAGRAM OF THE SYSTEM

The block diagram of the system is shown in figure 1. For simplicity, here we present the scheme for four users. Each user is equipped with four transmit antennas. Also, the system has one receiver with four receive antennas. Our designed scheme can be easily applied to L users with Ltransmit antennas and one receiver with L receive antennas only by adjusting the dimensions of channel matrices.

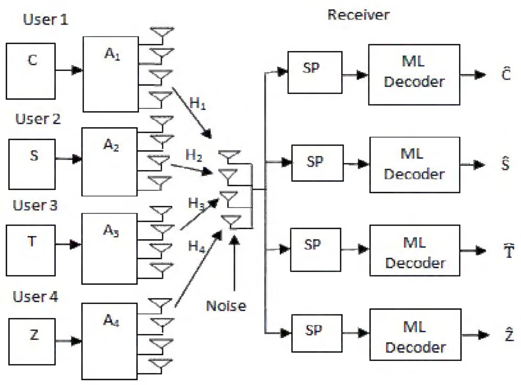

Figure 1: Block Diagram of System [1]

METHODOLOGY

In this paper, the channel model that we have assumed is quasi-static flat Rayleigh fading channel model. Also, we assume the channel matrices for users 1, 2, 3, 4 and that are given below:

$H_1 = [h_1\,(i,j)]_{4\times 4}, H_2 = [h_2\,(i,j)]_{4\times 4}$

$H_3 = [h_3\,(i,j)]_{4\times 4}, H_4 = [h_4\,(i,j)]_{4\times 4}$

Respectively. Here, main aim is to design the precoders using the channel information. So, at the l^{th} time slot, $l = 1, 2, 3, 4$, the precoders for users 1, 2, 3, 4 are:

$A_1^l = [a_1^l(i,j)]_{4\times 4}, A_2^l = [a_2^l(i,j)]_{4\times 4}$

$A_3^l = [a_3^l(i,j)]_{4\times 4}, A_4^l = [a_4^l(i,j)]_{4\times 4}$

Respectively. Here, we have considered the TDMA scheme. So, users 1, 2, 3, 4 send Quasi Orthogonal Space-Time Block Codes (QOSTBCs) in every four time slots. Hence, to cancel the interference, a simple way is to transmit the symbols ofthe four users along four orthogonal directions. Due to this, it is easy to achieve cancellation of interference at the receiver using zero-forcing. This zero forcing precoding can achieve performance close to the sum capacity when the number of users is larger or the system is interference-limited (i.e. noise is weak compared to the interference). In [18], a scheme that is based on Alamouti structure was proposed to cancel the interference for two users. But, when there are four users or more than two users in our system, then the above method does not work. Because four-dimensional rate-one complex orthogonal designs do not exist. Therefore, an alternative method is to use quasi-orthogonal structure, but due to its non-orthogonalityit cannot achieve full interference cancellation for every user.

So in this paper, wedeveloped a newscheme based onprecoder design to overcome all the above problemsas follows. In every first two time slots, we designed the precoders and according to that we transmit the symbols of user 1 and symbols of user 2 along two orthogonal directions respectively. Now, because of the characteristic of the designed precoders, each element of the equivalent channel matrices for users 1 and 2 is still Gaussian. Then we designed theprecoders for users 3 and 4, such that the transmit directions of their signals are orthogonal to each other. But it is impossible to obtain this orthogonal structure because four-dimensional rate-one complex orthogonal designsdo not exist. So, due to this it is impossible to make each element of the equivalent channel matrices for Users 3 and 4 still Gaussian. And this is the main difference between the precoders for Users 1, 2 and the precoders for Users 3, 4, at the first 2 time slots.

Now, at the second 2 time slots, again we designed the precoders to make the transmit directions of signals orthogonal to each other. Now here we designed the precoders for Users 3 and 4 first, such that each element of the equivalent channel matrices for Users 3 and 4 is Gaussian. Then we designed the precoders for Users 1 and 2 to obtain the orthogonal structure. But due to absence of four-dimensional rate-one complex orthogonal designs, elements of the equivalent channel matrices for Users 1 and 2 will not be Gaussian at the second 2 time slots. After the complete design of precoder, information is send through the channel to receiver. Then at receiver information gets converted from serial to parallel form. After this decoding of information is done. Here the technique used for decoding is maximum likelihood detection. And at last the information that we get at receiver has a minimum bit error rate.

RESULTS

Figure 2 shows the simulation results for four users each with four transmit antennas and one receiver with four receive antennas. Result shows the graph of bit error rate versus signal to noise ratio. We know that there exist a inverse relationship between bit error rate and signal to noise ratio. So, from graph we can see that as bit error rate decreases signal to noise ratio increases and vice versa.

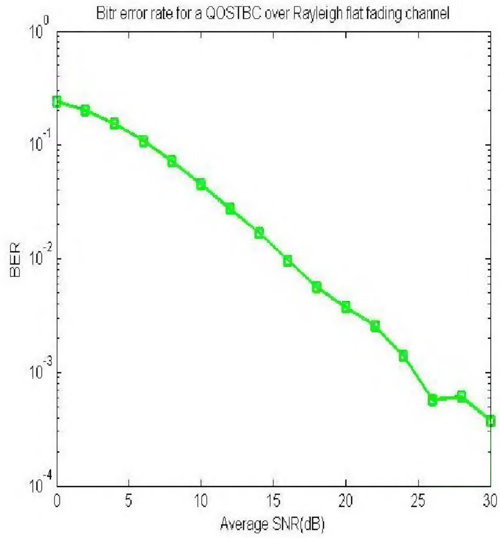

Figure 2: Simulation Result for Four Users

CONCLUSIONS

So, in this way system has achieved a minimum bit error rate. Also, system has a low complexity for more than two users each with four transmit antennas and one receiver with four receive antennas. The main idea of system is to design precoders using the channel information and make it possible for different users to transmit over the orthogonal directions. Hence using the orthogonality of the transmitted signals, the receiver is able to separate them and decode the signals independently. Hence interference cancellation is achieved.

REFERENCES

1. Feng Li and Hamid Jafarkhani, “Interference cancellation and detection for more than two users", *IEEE Trans* on communications, vol. 59, no. 3, march 2011.
2. V. Tarokh, H. Jafarkhani, and A. R. Calderbank, “Space-time block codes from orthogonal designs," *IEEE Trans. Inf. Theory*, vol. 45, pp.1456-1467, July 1999.

3. H. Jafarkhani, “A quasi-orthogonal space-time block code," *IEEE Trans. Commun.*, vol 49, no. 1, pp. 1-4, Jan. 2001.

4. V. Tarokh, A. Naguib, N. Seshadri, and A. R. Calderbank, “Combined array processing and space-time coding," *IEEE Trans. Inf. Theory*, vol.45. pp. 1121-1128, May 1999.

5. A. F. Naguib, N. Seshadri, and A. R. Calderbank, “Applications of space-time block codes and interference suppression for high capacity and high data rate wireless systems," in *Proc. 32nd Asilomar Conf. Signals, Syst. Comput.*, pp. 1803-1810, 1998.

6. A. Stamoulis, N. Al-Dhahir and A. R. Calderbank, “Further results on interference cancellation and space-time block codes," in *Proc. 35thAsilomar Conf. Signals, Syst. Comput.*, pp. 257-262, Oct. 2001.

7. J. Kazemitabar and H. Jafarkhani, “Multiuser interference cancellation and detection for users with more than two transmit antennas," *IEEE Trans. Commun.*, vol. 56, no. 4, pp. 574-583, Apr. 2008.

8. J. Kazemitabar and H. Jafarkhani, “Performance analysis of multiple-antenna multi-user detection," in *Proc. 2009 Workshop Inf. Theory Applications*, Feb. 2009.

9. A. Scaglione, P. Stoica, S. Barbarossa, G. Giannakis, and H. Sampath, “Optimal designs for space-time linear precoders and decoders," *IEEE Trans. Signal Process.*, vol. 50, no. 5, pp. 1051-1064, 2002.

10. D. Love and R. J. Heath, “Limited feedback unitary precoding for orthogonal space-time block codes," *IEEE Trans. Signal Process.*, vol.53, no. 1, pp. 64-73, 2005.

11. A. Ghaderipoor and C. Tellambura, “Optimal precoder for rate less than one space-time block codes," in *Proc. IEEE International Conf. Commun.*, Glasgow, Scotland, June 2007.

12. H. Sampath and A. Paulraj, “Linear precoding for space-time coded systems with known fading correlations," *IEEE Commun. Lett.*, vol. 6, no. 6, pp. 239-241, June 2002.

13. G. Jongren, M. Skoglund, and B. Ottersten, “Combining beamforming and orthogonal space-time block coding," *IEEE Trans. Inf. Theory*, vol. 48, pp. 611-627, Mar. 2002.

14. L. Liu and H. Jafarkhani, “Application of quasi orthogonal space-time block codes in beamforming," *IEEE Trans. Signal Process.*, vol. 53, no. 1, pp. 54-63, Jan. 2005.

15. S. Ekbatani and H. Jafarkhani, “Combining beamforming and space-time coding using quantized feedback," *IEEE Trans. Wireless Commun.*, vol. 7, no. 3, pp. 898-908, Mar. 2008.

16. C. W. Tan and A. R. Calderbank, “Multiuser detection of Alamouti signals," *IEEE Trans. Commun.*, vol. 57, no. 7, pp. 2080-2089, 2009.

17. Y. Wu and A. R. Calderbank, “Code diversity in multiple antenna wireless communication," in *Proc. IEEE International Symp. Inf. Theory*, Toronto, Canada, July 2008.

18. F. Li and H. Jafarkhani, “Multiple-Antenna Interference Cancellation and Detection for Two Users Using Precoders," *IEEE J. Sel. Topics Signal Process.*, vol. 3, no. 6, pp. 1066-1078, Dec. 2009.